The WaveOne single-file reciprocating system

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Fig. 1

Fig. 1_WaveOne Small (yellow), Primary (red) and Large (black) files.

_The new WaveOne NiTi file system from DENTSPLY Maillefer is a SINGLE-use, SINGLE-file system to shape the root canal completely from start to finish. Shaping the root canal to a continuously tapering funnel shape not only fulfils the biological requirements for adequate irrigation to rid the root-canal system of all bacteria, bacterial by-products and pulp tissue,[1] but also provides the perfect shape for 3-D obturation with gutta-percha.[2,3]

In most cases, the technique only requires one hand file followed by one single WaveOne file to shape the canal completely. The specially designed NiTi files work in a similar but reverse "balanced force" action[4] using a pre-programmed motor to move the files in a back and forth "reciprocal motion". The files are manufactured using M-Wire technology, improving strength and resistance to cyclic fatigue by up to nearly four times in comparison with other brands of rotary NiTi files.[5]

There are many dentists who, for whatever reason, are reluctant to use NiTi rotary instruments to prepare canals, despite the recognised advantages of flexibility, less debris extrusion and maintaining canal shape, amongst other advantages.[6–8] For them, the use of a single reciprocating file will be very attractive both in terms of time and cost saving.

At present, there are three files in the WaveOne single-file reciprocating system available in lengths of 21, 25 and 31 mm (Fig. 1):

1. The WaveOne Small file is used in fine canals. The tip size is ISO 21 with a continuous taper of 6%.
2. The WaveOne Primary file is used in the majority of canals. The tip size is ISO 25 with an apical taper of 8% that reduces towards the coronal end.
3. The WaveOne Large file is used in large canals. The tip size is ISO 40 with an apical taper of 8% that reduces towards the coronal end.

The instruments are designed to work with a reverse cutting action. All instruments have a modified convex triangular cross-section at the tip end

Fig. 2_WaveOne apical cross-section, modified convex triangular.
Fig. 3_WaveOne coronal cross-section, convex triangular.

Fig. 2

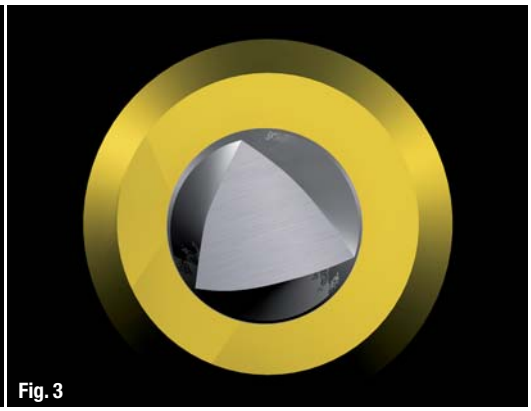

Fig. 3

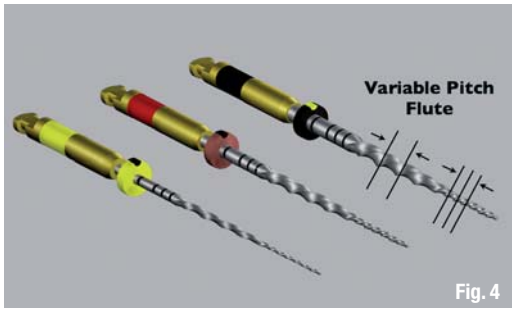

Fig. 4

Fig. 4_WaveOne variable pitch flute increases safety.

(Fig. 2) and a convex triangular cross-section at the coronal end (Fig. 3). This design improves instrument flexibility overall. The tips are modified to follow canal curvature accurately. The variable pitch flutes along the length of the instrument considerably improve safety (Fig. 4).

Because there is a possibility of cross-contamination associated with the inability to completely clean and sterilise endodontic instruments[9] and the possible presence of prion in human dental pulp tissue,[10] all instruments used inside root canals should be single use.[11] WaveOne instruments are a new concept in this important standard of care, as they are truly single use. The plastic colour coding in the handle becomes deformed once sterilised, preventing the file from being placed back into the handpiece.

The recommendation for single use has the added advantage of reducing instrument fatigue, which is an even more important consideration with WaveOne files, as one file does the work traditionally performed by three or more rotary NiTi files.

The WaveOne motor (Fig. 5) is rechargeable battery operated with a 6:1 reducing handpiece. The pre-programmed motor is set for the angles of reciprocation and speed for WaveOne instruments. The counter-clockwise (CCW) movement is greater than the clockwise (CW) movement. CCW movement advances the instrument, engaging and cutting the dentine. CW movement disengages the instrument from the dentine before it can (taper) lock into the canal. Three reciprocating cycles complete one complete reverse rotation and the instrument gradually advances into the canal with little apical pressure required.

All brands of NiTi files can be used with the WaveOne motor, as it has additional functions for continuous rotation. However, as WaveOne files have their own unique reverse design, they can ONLY be used with the WaveOne motor with its reverse reciprocating function.

The WaveOne technique involves the following stages:

1. straightline access, accepted protocol;
2. WaveOne file selection;
3. single-file shaping;
4. copious irrigation with 5% NaOCl and EDTA before, during and after single-file shaping.

Fig. 5

Fig. 5_WaveOne motor and 6:1 reducing handpiece.

_WaveOne file selection and clinical procedure (Figs. 6–8)

Whilst a good preoperative periapical radiograph will give an indication of what to expect before the canal is prepared (size and length of the canal, number of canals, degree and severity of curvature),

Figs. 6–8_WaveOne Small, Primary and Large files with their respective file selection and clinical procedural flow chart.

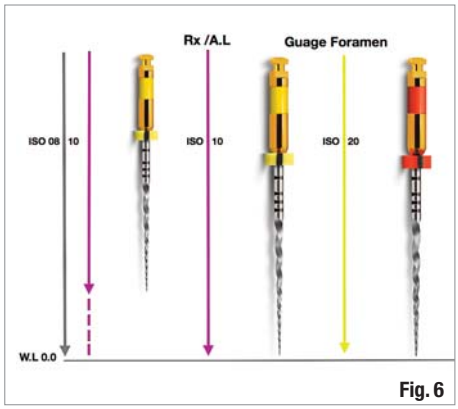

Fig. 6

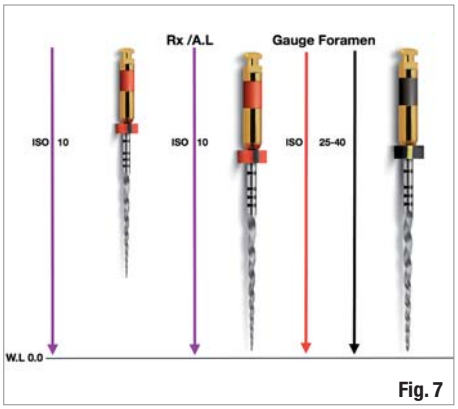

Fig. 7

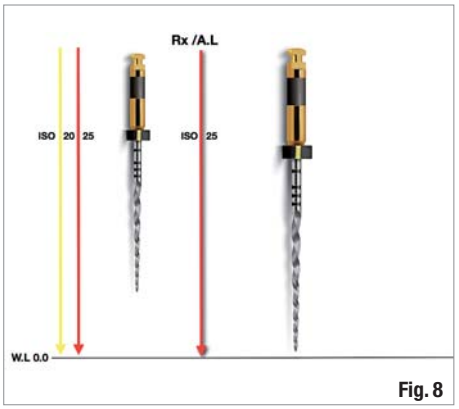

Fig. 8

Fig. 9

Fig. 13

Fig. 9_EndoActivator irrigation device.

Fig. 13_Calamus Dual 3-D Obturation System.

only the first hand file into the canal will aid in the selection of the WaveOne file as follows:

1. If a 10 K-file is very resistant to movement, use WaveOne Small file.
2. If a 10 K-file moves to length easily, is loose or very loose, use WaveOne Primary file.
3. If a 20 hand file or larger goes to length, use WaveOne Large file.

Single-file shaping

1. take hand file into canal and watch-wind to length or resistance (approximately two-thirds of canal length);
2. use appropriate WaveOne file to approximately two-thirds of canal length;
3. irrigate copiously;
4. take hand file to length and confirm with an apex locator and radiograph;
5. take WaveOne file to length;

Fig. 10_WaveOne matching paper points.

Fig. 11_WaveOne matching gutta-percha points.

Fig. 12_WaveOne matching Thermafil obturators.

Fig. 10

Fig. 11

Fig. 12

6. confirm foramen diameter with hand file the same size as WaveOne file; if snug, preparation is complete;
7. if foramen diameter is larger than WaveOne file, consider the next larger WaveOne file;
8. majority of cases will be completed with WaveOne Primary file.

Guidelines for use

1. use WaveOne files with a progressive up and down movement no more than three to four times, only little force is required;
2. remove file regularly, wipe clean, irrigate and continue;
3. if file does not progress, confirm patent canal and consider using a smaller WaveOne file;
4. whilst glide path management is minimal with WaveOne shaping files, some practitioners will be more comfortable if the glide path is first secured with PathFiles (DENTSPLY Maillefer);
5. in severely curved canals, complete apical preparation by hand if reproducible glide path is not possible;
6. WaveOne files can be used to relocate the canal orifice and expand coronal shape; even in a reciprocating motion use them with a "brushing" action short of length to achieve this;
7. never work in a dry canal and constantly irrigate with NaOCl and later EDTA;
8. as preparation time is short, activate the irrigating solutions to enhance their effect; the EndoActivator (DENTSPLY Maillefer) is ideal for this (Fig. 9).[12]

WaveOne obturating solutions

Obturation of the root-canal system is the final step of the endodontic procedure. The WaveOne system includes matching paper points, gutta-percha points and Thermafil WaveOne obturators (Figs. 10–12). The matching gutta-percha points can be used in conjunction with the Calamus Dual 3-D Obturation System (DENTSPLY Maillefer; Fig. 13) as demonstrated in the following cases.

Figs. 14a–c_Pre-op radiograph of #36 showing narrow and curved canals (a). Post-op radiographs: Canals were shaped with a WaveOne Primary file and filled with gutta-percha with WVC (b & c).

Figs. 15a–c_Pre-op radiograph of #16 showing severely curved MB and DB canals (a). Post-op radiographs: Canals were shaped with a WaveOne Primary file and filled with gutta-percha with WVC (b & c).

_Case studies

Case I (Figs. 14a–c)

Tooth #36 presented with symptoms of irreversible pulpitis and early apical periodontitis. Initial radiographic assessment showed four narrow and curved canals. Access was made and all canals were worked to length with a 10 K-file. A WaveOne Primary file (25.08) was selected and length was reconfirmed with a 10 K-file. The WaveOne Primary file was worked to length in all four canals. Obturation was done with warm vertical condensation (WVC) using Calamus Dual.

Case II (Figs. 15a–c)

Tooth #16 had symptoms of acute pulpitis with a temporary filling, covering exposure distally, as well as severe curvature of the mesiobuccal (MB) canals and apically in the distal canal. K-files 8 and 10 were taken to length in all the canals. A WaveOne Primary file (25.08) was selected. Length was confirmed with a 10 K-file. The WaveOne Primary file was taken to length in all the canals. Obturation was done with WVC using Calamus Dual.

Case III (Figs. 16a–c)

Tooth #17 presented with radiographic evidence of apical periodontitis and was non-vital. The canals were hardly visible on the preoperative X-ray. Primary consideration would have been a WaveOne Small file (21.06). In all canals, the 8 K-file moved to length easily. The 10 K-file also moved to length but was tight.

A WaveOne Primary file (25.08) was selected and taken to approximately three-quarters of the length. Recapitulation was achieved with a 10 K-file to length. The WaveOne Primary was taken to length in all the canals and the canals were then obturated with WVC.

Figs. 16a–c_Pre-op radiograph of #17 with canals hardly visible (a). Post-op radiographs: Canals were shaped with a WaveOne Primary file and filled with gutta-percha with WVC (b & c).

Figs. 17a–c_Pre-op radiograph of #17 with canals barely visible and #15 with a quite large canal (a). Post-op radiographs: #17 canals were shaped with a WaveOne Primary file. #15 canal was shaped with a WaveOne Large file. All canals were filled with gutta-percha with WVC (b & c).

Fig. 18a

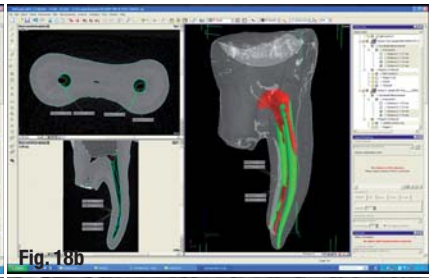
Fig. 18b

Fig. 18c

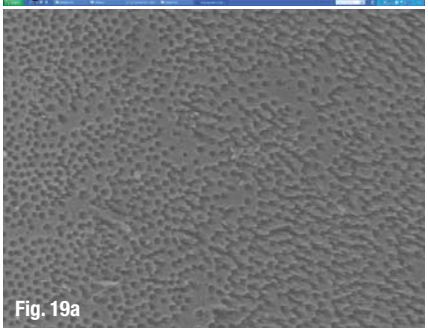
Fig. 19a

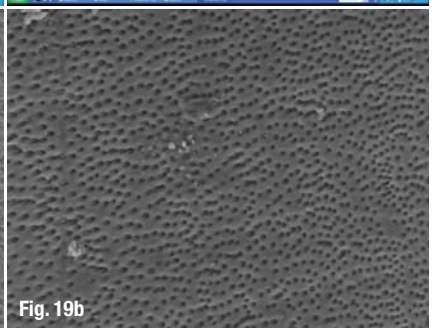
Fig. 19b

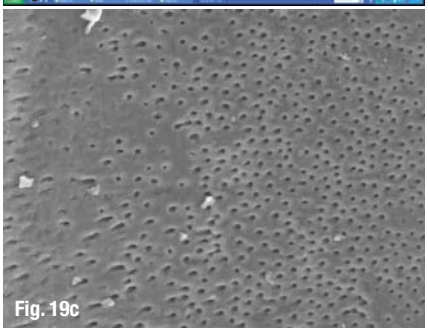
Fig. 19c

Figs. 18a–c_Micro-focus CT scan at coronal level (a), mid-root level (b) and apical level (c) of the mesial canals of the lower first molar demonstrates the excellent centring and shaping ability of the WaveOne Primary file.

Figs. 19a–c_A SEM representative sample at coronal level (a), mid-root level (b) and apical level (c) of the canal wall, showing excellent cleanliness and open dentinal tubules after shaping with a WaveOne Primary file and assisted irrigation with the EndoActivator.

Case IV (Figs. 17a–c)

Tooth #16 presented with radiographic evidence of asymptomatic apical periodontitis. The canals were hardly visible on the preoperative X-ray. The MB canal was severely curved, and the distobuccal (DB) and palatal canals were not visible. A 10 K-file moved to length easily in the MB and DB canals. In the palatal canal, 10 and 15 K-files moved to length easily. A WaveOne Primary file (25.08) was selected for all canals. Lengths were confirmed and the canals were shaped to length with WaveOne files.

In tooth #15, a large, single canal was clearly visible. 20 and 25 K-files went to length and a WaveOne Large file (40.08) was selected. Canal length was confirmed and the WaveOne Large file was used to shape the canal.

_Advantages of the WaveOne file reciprocating system

1. only one NiTi instrument per root canal and in most cases per tooth;
2. lower cost;
3. less instrument separation owing to the unique reciprocating movement that will prevent and/or delay the instrument advancing from plastic deformation to its plastic limit;
4. decreases global shaping time, allowing the clinician to spend more time cleaning the root-canal system with enhanced irrigation techniques;
5. eliminates procedural errors by using a single instrument rather than using multiple files;
6. a new standard of care, eliminating the possibility of prion contamination owing to single use;
7. easy to learn;
8. easy to teach.

_WaveOne research

The Nova Southeastern University College of Dental Medicine in the USA is conducting research into WaveOne. The following areas of research, amongst others, are being investigated using micro-focus CT scanning technology, which provides remarkable insight into:

1. canal-centring ability of WaveOne[13] (Figs. 18a–c);
2. remaining canal wall thickness after instrumentation with WaveOne;[14]
3. final shape versus initial shape of the canal with WaveOne;[15]
4. canal wall cleanliness with WaveOne[16] (Figs. 19a–c).

Other areas of research are flexibility,[17] fatigue[18] and debris extrusion.[19] To date, the results of these studies suggest that WaveOne single reciprocating files are comparable in performance to all the major leading brands of NiTi files that operate in continuous rotation.

_Conclusion

The WaveOne system is an exciting new concept in the preparation of the root canal. Whilst current teaching advocates the use of multiple NiTi files of different diameter and taper to gradually enlarge the root canal, only one WaveOne single shaping file is required to prepare the canal to an adequate size and taper, even in narrow and curved canals.

However, along with this, there must be a caveat. WaveOne files only shape the canal, extremely quickly in many instances, but they do not clean the root canal. It is the duty of teachers, clinicians and manufacturers to emphasise the role and importance of

irrigation as a major determinant of endodontic success. Once it is fully appreciated that shaping and cleaning the root-canal system are irrevocably intertwined, then endodontics will be easier for all and available to all, and WaveOne will truly become the root-canal preparation instrument of the future.

Drs Julian Webber, Pierre Machtou, Wilhem Pertot, Sergio Kuttler, Clifford Ruddle and John West where involved in the development, field testing and research associated with WaveOne._

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_about the lead author

roots

Dr Julian Webber has been a practising endodontist in London, England, for over 30 years. He was the first UK dentist to receive a Master's degree in Endodontics from a university in the USA (Northwestern University Dental School, Chicago) in 1978. He has lectured extensively and given many hands-on courses on endodontics worldwide. He has written in numerous peer-reviewed journals and contributed numerous chapters in endodontic texts. Dr Webber is a former President of the British Endodontic Society, a faculty member of the Pacific Endodontic Research Foundation in San Diego, Honorary Professor at the University of Belgrade, Serbia, and an Honorary Member of the Ukrainian Medical and Stomatological Academy. He is a fellow of the International College of Dentists and an active member of the American Association of Endodontists. He is the editor of *Endodontic Practice* (UK) and a board member of many prestigious dental journals.

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